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# 浙江产7种菝葜的染色体研究*

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# A CHROMOSOMAL STUDY ON 7 SPECIES OF *SMILAX* L.*

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**Summary** The chromosome numbers and karyotypes of 7 species of *Smilax* L. in Liliaceae (s. l.) are cytotaxonomically studied in this work. Their karyotypic characters, distinction between the species and the chromosomal basis of sexual differentiation are discussed. The karyotypes of most species are first reported. The results are shown as follows (see Tables 1—4 for the chromosome parameters and the karyotype constitution; Fig. 1 for their idiograms):

1. **Smilax nipponica** Miq. The species is one of the herbaceous species distributed in East Asia. Two karyotypes, 2n = 26(type A) and 2n = 32 (type B), are found in the species (Plate 1: 1—7). The karyotype of No. 88032 (uncertain of sexuality) is $2n = 26 = \overset{\text{L}}{2m + 6st} + \overset{\text{M}}{6m + 4sm} + \overset{\text{S}}{6sm + 2st}$. The karyotype has 4 pairs of L chromosomes, of which the first three pairs are subterminal, and the 4th is median. The karyotype belongs to 3B. No. 88045 (the male) and No. 88046 (the female) have 2n = 32. Their karyotypes are basically uniform, and both are $2n = 32 = \overset{\text{L}}{2m + 4sm + 2st} + \overset{\text{M}}{2m + 4sm} + \overset{\text{S}}{6m + 10sm + 2st}$, also with 4 pairs of L chromosomes, but the 2nd pair is median, and thus different from the type A. The karyotype belongs to 3B. The first pair of chromosomes of the male are distinctly

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unequal in length, with the D. V. (0.93) of relative length between them obviously greater than that of the female (0.1). The pair seems to be of sex-chromosomes. Sixteen bivalents (n = 16) were observed at PMCs MI of No. 88045 (Plate 1: 4). The major difference between the karyotypes A and B are greater relative length of L chromosomes in the type A than in the type B, and the increase of chromosome number in the karyotype B mainly due to the increase of st chromosomes. Nakajima (1937) reports 2n = 30 for *S. hederacea* var. *nipponica* (=*S. nipponica*, Wang and Tang, 1980).

2. **S. riparia** A. DC. This species is also herbaceous, distributed in East Asia. Thirty chromosomes were found in root-tip cells (uncertain of sexuality). The karyotype is $2n = 30 = \overset{L}{8st} + \overset{M}{6sm + 2st} + \overset{S}{6m + 6sm + 2st}$ (Plate 3: 1, 5), consisting mainly of sm and st chromosomes. There are 4 pairs of L chromosomes which are all subterminal and the m chromosomes appear to fall all into S category. Though the karyotype belongs to 3B, it is less symmetrical than that of *S. nipponica*. The species is karyologically rather different from *S. nipponica*, therefore. The first pair of chromosomes of this material are unequal in length, and it may be a male. The karyotype of this species is first reported.

3. **S. sieboldii** Miq. The species is a thorny climbing shrub, distributed in East Asia. At PMCs AII, 16 chrompsomes (n = 16) were found (Plate 2: 6), in accordance with Nakajima's (1933) report for a Japanese material.

4. **S. china L.** This species, a thorny climbing shrub, is of a wide distribution range mainly in East Asia and Southeast Asia. Two karyotypes were observed in different populations. (1) The population from Xikou has $2n = 96(6x) = \overline{20st + L} + \overset{M}{6t + 6sm + 12st} + 52(S)$ (Plate 3:7), of which the first three pairs of chromosomes are terminal, different from those in the other species. The arm ratios of both L and M chromosomes are larger than 2.0, which resembles those of *S. davidiana*. (2) PMCs MI of the population from Shangyu shew 15 chromosomes (n = 15). The hexaploid of the species is recorded for the first time. Hsu (1967,1971) reported 2n = 30 from Taiwai and Nakajima (1937) recorded n = 30 from Japan, which indicates that the karyotype of the species varies not only in ploidy, but also in number.

5. **S. davidiana** A. DC. The somatic cells were found to have 32 chromosomes, and PMCs MI shew 16 bivalents (Plate 2: 1—5). The karyotype is $2n = 32 = \overset{L}{8st} + \overset{M}{4sm + 4st} + \overset{S}{8sm + 8st}$. The karyotype belongs to 3B, and is less symmetrical than those in herbaceous species. The D. V. (0.20) of relative length between the two homologues of the first pair is slightly larger in the male than in the female (0.14), and it is thus difficult to determine whether they are sexual chromosomes or not.

6. **S. glabra** Roxb. The species is a non-thorny climbing shrub, distributed in East Asia and Southeast Asia. 32 chromosomes were found in somatic cells. The

karyotype is $2n = 32 = \overset{L}{8st} + \overset{M}{10st + 6sm} + \overset{S}{8st}$ (Plate 3: 2, 6), with only 3 pairs of sm chromosomes (12, 13 and 16th). The karyotype is more asymmetric than that of *S. davidiana*, although it is also of 3B (Table 1). The karyotype is first reported for the species.

7. **S. nervo-marginata** Hay. var. **liukiuensis** (Hay.) Wang et Tang The variety has a relatively narrow distribution range, mainly occurring in eastern China. The chromosomal number of somatic cells is $2n = 32$ (Plate 3: 3—4). The karyotype is $2n = 32 = \overset{L}{2sm + 6st} + \overset{M}{2sm + 2st} + \overset{S}{2m + 6sm + 12st}$, evidently different from that of *S. glabra*. The first pair of chromosomes are submedian, and much longer than the 2nd to 4th pairs. The ratio in length of the largest chromosome to the smallest one is 4.3. The symmetric degree is of 3C, a unique type. The karyotype of the species is reported for the first time.

In *Smilax*, the known basic numbers are 13, 15, 16 and 17. The two herbaceous species distributed in East Asia have three basic numbers: 13, 15 and 16, while the woody species studied mainly have 16, with no 13 recorded. Mangaly (1968) studied 8 herbaceous species in North America and reported $2n = 26$ for them except *S. pseudo-china* with $2n = 30$. Mangaly considered that a probably ancestral home of *Smilax*, both the herbaceous and woody, is in Southeast Asia and the eastern Himalayas, and speculated that the ancestral type of Sect. Coprosmanthus is possibly an Asian species, *S. riparia*. The karyotypes of the two herbaceous species in East Asia consist mostly of sm and m chromosomes, whereas those for the North American species are all of st chromosomes. Based on the general rule of karyotypic evolution, i.e. from symmetry to asymmetry, his speculation seems reasonable.

Researches on sex-chromosomes of *Smilax* have been carried out since 1930 (Lindsay, 1930; Jensen, 1937; Nakajima, 1937; Mangaly, 1968), and they are generally considered to be the largest pair, but there is still no adequate evidence. The result of our observation on *S. nipponica* may confirm that the first pair of chromosomes of this species is XY type of sex-chromosomes.

Chromosomes of the genus are small and medium-sized, varying between 1—6 μm, slightly larger in herbaceous species than in woody ones, larger in the karyotype of $2n = 26$ than in that of $2n = 32$. Based on karyotype constitution of the above 5 species, the karyotype in the genus is characterized by 4 pairs of L chromosomes and 2—5 pairs of M chromosomes, and mostly st and sm chromosomes, and by rather asymmetrical 3B type. The degree of symmetry in the above 5 species is from Sect. Coprosmanthus to Sect. Coilanthus, and herbaceous species to woody ones.

**Key words**　Karyotype; Cytotaxonomy; *Smilax*; Zhejiang; China

**摘要**　本文报道浙江产菝葜属 *smilax* 7 个种的染色体数目和核型。*S. nipponica* 有两种核型，$2n = 26$ 和 $2n = 32$，均为 3B 型，但后一种细胞型的雄株的第一对染色体大小不等，可能为性染色体；*S. riparia* $2n = 30$，属 3B 型；*S. siebodii* $n = 16$；*S. china* 有两个染色体数目，$2n = 96$ 和 $n = 15$；*S. davidiana* $2n = 32$，属 3B 型，对减数分裂 MI 的观察发现 $n = 16$；*S. glabra* $2n = 32$，亦属 3B 型；*S. nervo-marginata* var. *liukiuensis* $2n = 32$，属 3C 型。讨论了种间在核型上的差异、属的基数、核型演化趋势和性染色体等问题。

**关键词** 核型;细胞分类;菝葜属;中国

菝葜属 *Smilax* L. 是广义的百合科中一个雌雄异株的木本属（极少为草本）。目前该属普遍作为菝葜科 Smilacaceae 中的一个主要成员，另一个成员是肖菝葜 *Heterosmilax*（包括 *Pseudosmilax*）。*Smilax* 约有 300 种，广布于全球热带和亚热带地区，我国约产 60 种，主要产于长江以南。由于雌雄异株，种类繁多，形态变异幅度较大，因而其分类难度较大。Koyama (1960) 曾对本属的分类作过较系统的研究。汪发缵和唐进 (1978) 对国产种的分类作了全面研究。但在属下组的划分上，广布种种内及种间界限的确立上和草本种的归属问题上各学者仍有分歧 (Mangaly 1968)。其次该属(科)在广义百合科乃至单子叶植物中的分类地位、起源中心、系统发育以及性别分化的染色体基础等问题，虽前人从不同角度作过讨论，但仍然有待进一步系统全面地研究。

本属细胞学的研究，最初起于 Elkins (1914) 和 Lindsay (1930) 对 *S. herbacea* 的工作，报道 n = 13。此后半个多世纪，人们先后对 20 多种作了染色体数目的报道，其中 Mangaly (1968) 对北美产 8 个草本种作了较详细的研究。但至今为止对核型分析的报道很少。国产种除 Nakajima (1933, 1937) 报道 *S. china* n = 30, *S. sieboldii* n = 16; Hsu (1967) 报道 *S. china* 2n = 30 外，其余尚未见报道，尤其对核型的详细研究尚未见到。本文旨在以浙江产菝葜属植物为材料，进行细胞分类学的研究，为该属乃至广义的百合科的系统发育研究提供资料。本文报道了 7 个种的染色体数目和核型，有些种对雌雄植株分别作了分析，其中 4 种为首次报道。

## 材 料 和 方 法

材料采自野外自然生长的植株或移栽于浙江农业大学植物园花盆中的植株，取生长旺盛的根尖、茎尖和幼小的花药。根尖用 0.05% 的秋水仙碱液或 0.002mol/L 8-羟基喹啉溶液处理 2—4 小时，卡诺固定液固定过夜，在 0.1mol/L HCl 中于 60℃ 水解 8—10 分钟，用石炭酸品红滴染压片。花药材料直接用卡诺液固定，其余略同根尖材料。核型分析按全国第一次植物染色体学术讨论会建议的标准(李懋学等 1985)。

材料来源见附录，凭证标本存放在中国科学院植物研究所标本馆 (PE) 和浙江农业大学植物标本室。

## 结 果 与 讨 论

### (一) 菝葜组 Sect. **Coprosmanthus** Torrey

1. **白背牛尾菜** *S. nipponica* Miq，本种系广布东亚的草本种。我们的材料采自浙江东部四明山。观察到两个不同的核型：2n = 26 和 2n = 32（图版 1：1—3, 5—7），核型模式图见图 1 的 A. C. D，核型构成和染色体参数见表 1 和表 2。88032 号植株

$$(♀)2n = 26 = \underset{\text{L}}{2m + 6st} + \underset{\text{M}}{6m + 4sm} + \underset{\text{S}}{6sm + 2st}*$$

。核型特点是有 4 对较大的染色

* L. 较大型染色体，相对长度大于 8.0；M. 中型，相对长度大于 6.0，小于 8.0；S. 小型，相对长度小于 6.0。

Table 1　The karyotypes of 7 species in *Smilax* from Zhejiang Province

| Species | n | 2n | Absolute length (μm) | Karyotypic constitution** L m sm st t | M m sm st t | S m sm st t | Symmetric degree: longest/shortest | proportion of chromosomes with arm ratio > 2 | Type |
|---|---|---|---|---|---|---|---|---|---|
| Present results | | | | | | | | | |
| *S. nipponica* | 16 | 26 | 1.58—5.9 | 2 6 | 6 4 | 6 2 | 3.19 | 0.54 | 3B |
| | | 32 | 1.7—5.3 | 2 4 2 | 2 4 | 6 10 2 | 3.28 | 0.63 | 3B |
| *S. riparia* | | 30 | 1.4—4.2 | 8 | 6 2 | 6 6 2 | 3.05 | 0.8 | 3B |
| *S. sieboldii* | 16 | | | | | | | | |
| *S. china* (SP)* (XP)* | 15 | 96 | 0.99—3.6 | 20 6 | 6 12 | total 52 | | | |
| *S. davidiana* | | 32 | 1.4—3.9 | 8 | 4 4 | 8 8 | 2.89 | 0.94 | 3B |
| *S. glabra* | | 32 | 1.4—4.5 | 8 | 10 | 6 8 | 3.07 | 0.94 | 3B |
| *S. nervo-marginata* | | 32 | 1.3—4.5 | 2 6 | 2 2 | 2 6 12 | 4.30 | 0.94 | 3C |

* SP. Shangyu population; XP. Xikou population.

** L. Large chromosome, the relative length > 8.0; M. middle chromosome, 8.0 > the relative length > 6.0; S. small chromosome, the relative length < 6.0.

Table 2　The parameters of chromosomes in *S. nipponica*

| No. | 2n = 26 (uncertain of sexuality) Relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types | 2n = 32 The male Relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types | The female Relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15.2=12.8+2.40 | 5.39 | 1.38 | st | 11.6=8.76+2.84 | 3.08 | 0.40 | st | 11.6=8.68+2.92 | 2.99 | 0.14 | sm |
| 2 | 11.2=9.42+1.78 | 5.41 | 0.32 | st | 9.58=6.10+3.48 | 1.75 | 0.48 | sm | 9.86=5.96+3.90 | 1.53 | 0.14 | m |
| 3 | 10.66=8.44+2.22 | 3.80 | 0.71 | st | 9.06=6.70+2.36 | 2.84 | 0.40 | sm | 8.80=6.44+2.36 | 2.73 | 0.28 | sm |
| 4 | 9.18=5.00+4.18 | 1.20 | 0.10 | m | 8.20=6.40+1.80 | 3.55 | 0.51 | st | 8.66=6.56+2.10 | 3.14 | 0.37 | st |
| 5 | 7.74=4.46+3.28 | 1.36 | 0.26 | m | 7.34=5.66+1.68 | 3.39 | 0.70 | st | 6.76=4.82+1.94 | 2.48 | 0.55 | sm |
| 6 | 6.98=4.22+2.76 | 1.53 | 0.22 | m | 6.60=4.11+2.49 | 1.65 | 0.25 | m | 6.58=4.00+2.58 | 1.55 | 0.43 | m |
| 7 | 6.80=4.64+2.16 | 2.15 | 0.11 | sm | 6.32=4.70+1.62 | 2.90 | 0.89 | sm | 6.04=4.56+1.48 | 3.08 | 0.54 | st |
| 8 | 6.66=4.32+2.34 | 1.85 | 0.12 | sm | 5.78=4.04+1.74 | 2.32 | 0.24 | sm | 5.84=4.22+1.62 | 2.60 | 0.45 | sm |
| 9 | 6.44=4.00+2.44 | 1.64 | 0.54 | m | 5.66=3.20+2.46 | 1.30 | 0.29 | m | 5.52=3.42+2.10 | 1.63 | 0.38 | m |
| 10 | 5.84=3.70+2.14 | 1.73 | 0.34 | sm | 5.52=3.68+1.84 | 2.00 | 0.24 | sm | 5.06=3.38+1.68 | 2.01 | 0.39 | sm |
| 11 | 5.02=3.74+1.28 | 2.92 | 0.76 | sm | 5.04=3.94+1.10 | 3.58 | 0.55 | st | 5.00=3.84+1.16 | 3.31 | 0.76 | st |
| 12 | 5.00=3.42+1.58 | 2.16 | 0.51 | sm | 4.58=3.28+1.30 | 2.52 | 0.18 | sm | 4.56=3.02+1.54 | 1.96 | 0.48 | sm |
| 13 | 4.76=3.60+1.16 | 3.10 | 0.42 | st | 4.24=2.40+1.84 | 1.30 | 0.22 | m | 4.50=2.52+1.98 | 1.27 | 0.10 | m |
| 14 | | | | | 3.90=2.64+1.26 | 2.10 | 0.38 | sm | 4.30=2.78+1.52 | 1.83 | 0.44 | sm |
| 15 | | | | | 3.58=2.36+1.22 | 1.93 | 0.44 | sm | 3.86=2.60+1.26 | 2.07 | 0.27 | sm |
| 16 | | | | | 3.42=1.94+1.48 | 1.31 | 0.21 | m | 3.64=2.14+1.50 | 1.43 | 0.30 | m |

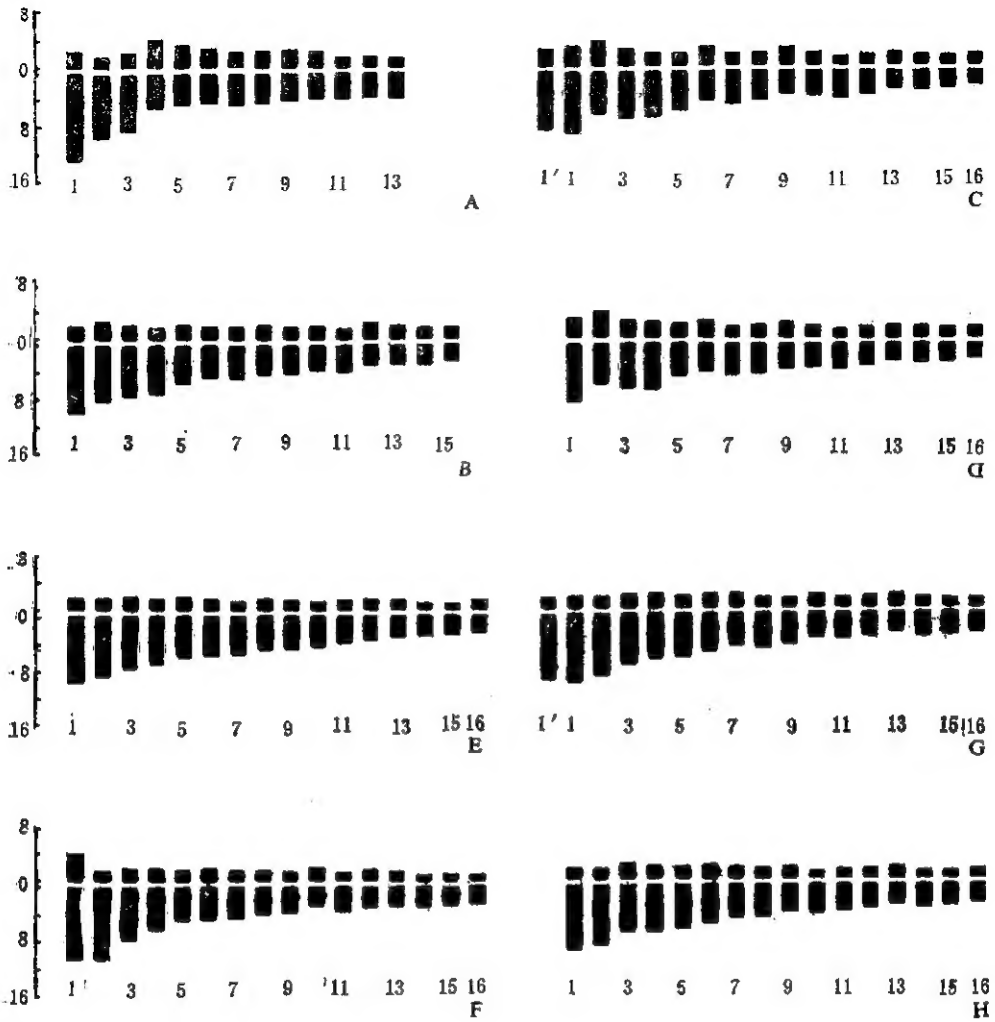


图 1 菝葜属五个种的核型模式图

Fig. 1 Idiograms of 5 species of *Smilax*.

A. C. D. *S.nipponica*, A. 2n = 26, C. D. 2n = 32, C. the male, No. 1 & 1′ probably sex-chromosomes, D. the female; B. *S. riparia*; E. *S. glabra*; F. *S. nervo-marginata*; G. H. *S. davidiana*, G. the male, No. 1 & 1′ probably sex-chromosomes, H. the female.

体(相对长度大于 8.0)，其中第 1—3 对为 st 着丝点的，第 4 对为 m 着丝点的。整个核型以 sm 和 m 着丝点染色体为主，最长与最短染色体比值为 3.19，核型类型属 3B 型。绝对长度的平均变化范围在 1.58—5.90$\mu$m。88045 号植物(♂)与 88046 号植物(♀)为 2n=32，核型构成上基本是一致的，仅少数几对染色体的着丝点类型有出入(见表 2)。但这种差异如考虑臂比的 95% 置信区间就不存在了。 ♂株 $2n = 32 = \overset{L}{4sm + 4st} + \overset{}{2m} + \overset{M}{2sm + 2st} + \overset{S}{6m + 10sm + 2st}$；♀株 $2n = 32 = \overset{L}{2m + 4sm + 2st} + \overset{M}{2m + 2sm + 2st} +$

6m + 10sm + 2st。88045 号植株(♂)的 PMCs MI 表明 n=16(图版 1:4)。将 2n = 32 的♂株和♀株的染色体参数平均，得出该细胞型的总核型公式 $32=2m+4sm+2st+2m+4sm+6m+10sm+2st$。核型特点是也具 4 对较大染色体，但其中的 m 着丝点染色体位于第 2 对。整个核型也以 sm 和 m 着丝点染色体为主，最长与最短染色体的比值为 3.28，属3B 核型。绝对长度的平均变化范围在 1.68—5.31$\mu$m。

♂株的第一对染色体明显异型，相对长度差值(0.93)显著大于♀株(0.1)，可能为性染色体。

两种细胞型 (2n = 26 与 32) 之间的差异主要表现在：(1) 2n = 26 者核型的 4 对 (L) 染色体的相对长度显著大于后者 (2n = 32)；(2) 2n = 32 者核型的染色体数目的增加主要是小染色体的增加。

该种的核型为首次报道。在以往记载中，Nakajima (1937) 对日本产 *S. hederacea* var. *nipponica* (=*S. nipponica*) 的染色体数目作了报道：2n = 30，在 PMCs MI 发现有不等对存在，认为可能是性染色体，但未作核型分析。由此可见，该种存在一系列染色体数目不等的细胞型。

2. **牛尾菜** *S. riparia* A. DC.，本种为多年生草质藤本，其分布比白背牛尾菜更广，北到我国东北、日本、朝鲜，南可达菲律宾。我们的材料采自浙江天目山，体细胞观察到 30

Table 3 The parameters of chromosomes in 3 species of *Smilax*

| No. | *S. riparia* 2n = 30 | | | | *S. glabra* 2n = 32 | | | | *S. nervo-marginata* var. *liukiuensis* 2n = 32 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types | relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types | relative length | Arm ratio $\bar{x}$ | Arm ratio $\sigma_{n-1}$ | Types |
| 1 | 11.6=9.80+1.80 | 5.47 | 0.72 | st | 10.9=9.42+1.48 | 6.28 | 0.80 | st | 14.1=10.1+4.00 | 2.48 | 0.32 | sm |
| 2 | 10.5=8.10+2.40 | 3.43 | 1.09 | st | 10.0=8.62+1.38 | 6.25 | 1.09 | st | 11.9=10.4+1.50 | 6.92 | 0.44 | st |
| 3 | 9.38=7.44+1.94 | 3.84 | 0.74 | st | 9.22=7.58+1.64 | 4.62 | 0.97 | st | 9.46=7.50+1.96 | 3.83 | 0.33 | st |
| 4 | 8.60=7.02+1.58 | 4.44 | 0.66 | st | 8.44=6.96+1.48 | 4.70 | 0.66 | st | 8.02=6.07+1.95 | 3.11 | 0.45 | st |
| 5 | 7.42=5.48+1.94 | 2.82 | 0.54 | sm | 7.62=5.98+1.64 | 3.65 | 0.64 | st | 6.26=4.78+1.48 | 3.23 | 0.47 | st |
| 6 | 6.66=4.82+1.84 | 2.62 | 0.30 | sm | 7.08=5.70+1.38 | 4.13 | 0.54 | st | 6.22=4.50+1.72 | 2.62 | 0.27 | sm |
| 7 | 6.46=4.86+1.60 | 3.04 | 1.74 | st | 6.68=5.60+1.08 | 5.19 | 0.99 | st | 5.68=4.36+1.32 | 3.30 | 0.21 | st |
| 8 | 6.06=4.22+1.84 | 2.29 | 0.40 | sm | 6.28=4.78+1.50 | 3.19 | 0.51 | st | 5.30=4.00+1.30 | 3.08 | 0.63 | st |
| 9 | 5.66=4.16+1.50 | 2.77 | 0.53 | sm | 6.04=4.78+1.26 | 3.79 | 0.90 | st | 4.88=3.72+1.16 | 3.21 | 0.46 | st |
| 10 | 5.50=3.72+1.78 | 2.09 | 0.24 | sm | 5.42=4.40+1.02 | 4.31 | 0.84 | st | 4.70=2.76+1.96 | 1.42 | 0.21 | m |
| 11 | 5.20=3.96+1.24 | 3.19 | 0.86 | st | 5.10=3.90+1.20 | 3.25 | 0.60 | st | 4.48=3.38+1.10 | 3.07 | 0.54 | st |
| 12 | 4.96=2.80+2.16 | 1.30 | 0.35 | m | 4.74=3.38+1.36 | 2.48 | 0.58 | sm | 4.40=2.94+1.46 | 2.01 | 0.37 | sm |
| 13 | 4.58=2.84+1.74 | 1.63 | 0.59 | m | 4.16=2.78+1.38 | 2.01 | 0.54 | sm | 4.06=2.82+1.24 | 2.27 | 0.36 | sm |
| 14 | 4.28=2.88+1.40 | 2.06 | 0.35 | sm | 3.92=3.02+0.90 | 3.36 | 0.51 | st | 3.78=2.90+0.88 | 3.29 | 0.71 | st |
| 15 | 3.82=2.28+1.54 | 1.48 | 0.20 | m | 3.62=2.80+0.82 | 3.41 | 0.55 | st | 3.70=2.72+0.98 | 2.78 | 0.26 | sm |
| 16 | | | | | 3.56=2.30+1.26 | 1.83 | 0.54 | sm | 3.28=2.48+0.80 | 3.10 | 0.28 | st |

条染色体，2n = 30，♂♀未知。核型公式为 $2n = 30 = \overset{L}{8st} + \overset{M}{6sm} + 2st + \overset{S}{6m + 6sm} + 2st$，(见图版 3: 1, 5)，核型模式图见图 1: B，核型构成和染色体参数见表 1 和表 3。核型特点是相对长度大于 8.0 的较大染色体也为 4 对，且全为 st 着丝点，与 *S. nipponica* 明显不同；以 sm 和 st 着丝点染色体占多数，m 着丝点染色体仅在小染色体中出现；最大染色体相对长度为 11.64，与 *S. nipponica* 的 2n = 32 核型相近，也明显低于 2n = 26 的核型；最长与最短染色体的比值为 3.05，虽也属 3B 核型，但是臂比值大于 2.0 的染色体所占比例要大于 *S. nipponica*，从二者的乘积 2.44 更说明本种的对称性要低于 *S. nipponica*。牛尾菜 *S. riparia* 的核型中，第一对染色体也表现异型，相对长度的差值为 0.52，也较大。很可能该材料为雄性植株。本种核型和数目为首次报道。

3. **华东菝葜** *S. sieboldii* Miq.，本种为具刺攀援灌木，分布也较广，但主要分布我国亚热带至南温带的东部，我国台湾、日本和朝鲜均产。我们的材料取自浙江天目山近山顶处（海拔约 1400m）。PMCs 后期 II 可见 16 条染色体，n = 16（图版 2:6）。Nakajima (1933) 报道日本产材料 n = 16，可见 16 无疑是该种的基数。但我们在不同分裂相中也见到 n = 15 或 15 和 16 难以确定的情况，有待研究。

4. **菝葜** *S. china* L.，本种系具刺攀援灌木，分布很广，主产东亚及东南亚的热带与亚热带，往南可达泰国和缅甸，往北仅分布到山东半岛。我们的材料采自浙江东部的上余和溪口，二地的染色体基数和倍数均不同。溪口材料的根尖细胞观察到 2n = 96（图版 3:7），按基数 16 推测应属 6 倍体，2n = 6x = 96。其中（L）大型和（M）中等染色体占 44 条，(S) 小染色体共 52 条（(S) 染色体未作分析）。用公式可表示为 $2n = 96 = \overset{L}{20st} + 6t + \overset{M}{6sm} + 12st + 52(S)$。第 1—3 对大型染色体为 t 着丝点是该种核型的一个特点，与其它几种不同；全部大型和中等染色体的臂比均大于 2，这一点与近缘种 *S. davidiana* 相似。本种染色体绝对长度的平均变化范围在 0.99—3.56μm，明显小于其它 2 倍体种。然而在上余采的材料的 PMCs MI 中观察到 15 条染色体，n = 15(图版 2:7)。

该种的 6 倍体核型为首次记载。Nakajima (1937) 对该种作过研究，有过 n = 30 的记录；Hsu, C. C. (1967, 1971) 报道了台湾的材料 2n = 30，表明该种存在 2x, 4x 和 6x 三种倍性。中国植物志(汪发缵和唐进，1978) 曾提到该种的果实有两种类型：一种较大，干后易破裂；另一种较小，干后不易破裂。是否倍性水平与果实类型有相关性?值得进一步观察研究。我们观察到的 6 倍体核型的基数是否确是 16，有待进一步论证。

5. **小果菝葜** *S. davidiana* A. DC.，本种与菝葜近缘，以叶柄鞘耳状和果较小而区别；分布区小于 *S. china*，主产我国华东及华南沿海各省，东南亚也有分布。我们的材料采自浙东天台山，体细胞观察到 32 条染色体（图版 2: 1—5），由 8 条大型的（L），8 条中等的（M）和 16 条小型（S）染色体组成。核型模式图见图 1: G. H，染色体参数见表 1 和表 4。核型公式♂株为 $2n = 32 = \overset{L}{8st} + \overset{M}{4sm} + 4st + \overset{S}{8sm} + 8st$；♀株为 $2n = 32 = \overset{L}{8st} + \overset{M}{4sm} + 4st + \overset{S}{8sm} + 8st$。核型特点是以 st 着丝点染色体为主，无 m 着丝点染色体。4 对大型染色体全为 st 着丝点的。核型类型也为 3B 型，但最长与最短染色

体比值和臂比大于 2 的染色体所占百分比之乘积，显然大于草本种，表明对称性低于草本种。比较♂株和♀株的核型构成是基本一致的，仅第 9 与第 10 对染色体的顺序有所颠倒，表明这二对染色体的长度比较接近，容易受压片中或测量中产生的误差影响，并非本质区别。♂株的第一对同源染色体间相对长度的平均差值为 0.20，略大于♀株(0.14)，因此还难以肯定是否存在性染色体。该种绝对长度在 1.37—3.93$\mu$m 之间，低于其它 2x 种。PMCs 的材料采自浙东上余，在 MI 可见到 16 个二价体(图版 2: 2)。由此肯定 2n = 32 是存在于该种的。该种形态上与 *S. china* 接近，从核型构成中的 L 和 M 染色体看，与 6x 种 *S. china* 也是接近的。本种核型为首次报道。

**(二) 土茯苓组** Sect. **Coilanthus** A. DC.

6. **土茯苓** *S. glabra* Roxb.，本种系无刺攀援灌木，分布区也较广，主产长江流域以南各省，西北可达甘肃南部；东南亚以及印度也有分布。我们的材料系自浙江西北昱岭，植株的性别未知。体细胞观察到 32 条染色体 (图版 3: 2, 6)。核型公式为 $2n = 32 = \overset{-L-}{8st} + \overset{-M-}{10st} + \overset{-S-}{6sm + 8st}$，核型模式图见图 1: E，染色体参数列表 3。该种核型特点：以 st 着丝点为主，仅第 12、13 和 16 对为 sm 着丝点染色体；也具 4 对较大的染色体，均为 st 着丝点的；中等 (M) 的染色体有 5 对，多于其它种，并且也全为 st 着丝点的；最长与最短染色体之比值为 3.07，臂比大于 2 的染色体所占百分比为 0.94，尽管也为 3B 型，但二者的乘积(2.89)要大于菝葜组已研究的种类，即对称性要低于上述种类。该种染色体绝对长度平均变化范围在 1.44—4.53$\mu$m，略大于菝葜组的木本种 (*S. china* 和 *S. davidiana*)。本种核型为首次报道。

Table 4　The parameters of chromosomes in *S. davidiana*

| No. | The male | | | | The female | | | |
|---|---|---|---|---|---|---|---|---|
| | Relative length | Arm ratio | | Types | Relative length | Arm ratio | | Types |
| | | $\bar{x}$ | $\sigma_{n-1}$ | | | $\bar{x}$ | $\sigma_{n-1}$ | |
| 1 | 11.1=9.70+1.40 | 6.93 | 0.95 | st | 10.8=9.26+1.54 | 6.01 | 0.90 | st |
| 2 | 10.2=8.82+1.38 | 6.49 | 0.97 | st | 10.1=8.70+1.40 | 6.31 | 0.65 | st |
| 3 | 9.10=7.20+1.90 | 3.79 | 0.47 | st | 8.88=6.86+2.02 | 3.40 | 0.55 | st |
| 4 | 8.38=6.48+1.90 | 3.41 | 0.62 | st | 8.70=6.86+1.84 | 3.73 | 0.55 | st |
| 5 | 7.82=6.22+1.60 | 3.89 | 1.00 | st | 7.80=6.18+1.62 | 3.82 | 0.75 | st |
| 6 | 7.32=5.38+1.94 | 2.77 | 0.51 | sm | 7.32=5.44+1.88 | 2.89 | 0.43 | sm |
| 7 | 6.42=4.62+1.80 | 2.57 | 0.42 | sm | 6.36=4.76+1.60 | 2.98 | 0.59 | sm |
| 8 | 6.06=4.96+1.10 | 4.50 | 0.57 | st | 6.02=4.70+1.32 | 3.56 | 0.97 | st |
| 9 | 5.40=4.32+1.08 | 4.00 | 1.05 | st | 5.50=3.88+1.62 | 2.39 | 0.39 | sm |
| 10 | 5.32=3.60+1.72 | 2.09 | 0.62 | sm | 5.02=4.04+0.98 | 4.12 | 0.58 | st |
| 11 | 4.80=3.66+1.14 | 3.21 | 0.68 | st | 4.90=3.70+1.20 | 3.08 | 0.88 | st |
| 12 | 4.42=3.20+1.22 | 2.63 | 0.51 | sm | 4.50=3.28+1.22 | 2.69 | 0.50 | sm |
| 13 | 4.38=2.76+1.62 | 1.70 | 0.15 | sm | 4.46=2.88+1.58 | 1.82 | 0.43 | sm |
| 14 | 4.36=3.27+1.09 | 3.00 | 0.64 | st | 4.22=3.22+1.00 | 3.22 | 0.89 | st |
| 15 | 4.00=3.02+0.98 | 3.08 | 0.52 | st | 3.86=2.90+0.96 | 3.02 | 0.61 | st |
| 16 | 3.78=2.78+1.00 | 2.78 | 0.28 | sm | 3.80=2.72+1.08 | 2.52 | 0.31 | sm |

7. **缘脉菝葜**(无疣变种) *S. nervo-marginata* Hay. var. *liukiuensis* (Hay.) Wang et Tang，本种为无刺攀援灌木，分布区较狭，主产我国浙江、江西、安徽、湖南和贵州，琉球群岛也有。我们的材料采自浙江西北的昱岭，从形态看应属无疣变种。体细胞可见 32 条染色体，2n = 32 (图版 3: 3,4)。核型公式为 2n = 32 = 2sm + 6st + 2sm + 2st + 2m + 6sm + 12st，核型模式图见图 1: F，染色体参数列表 3。植株性别未知。核型构成与 *S. glabra* 相比差异很大，虽然也具有 4 对 L 染色体，但第 1 对染色体明显大于后三对，并且为 sm 着丝点的；其次 M 染色体减少到 2 对，而 S 染色体增加到 10 对；整个核型也以 st 着丝点染色体为多数，但有一对 m 着丝点出现；尽管臂比大于 2 的染色体所占百分比与 *S. glabra* 一样，但最大与最小染色体之比值达到 4.3，已属于 3C 型核型。不但明显不同于 *S. glabra*，而且在所研究的 7 个种中也是独特的。本种染色体绝对长度与 *S. glabra* 近似，为 1.31—4.5μm。核型为首次报道。

综上所述及文献记载，*Smilax* 属已知染色体基数在 13—17 之间。在本文报道的 7 个种中，草本种出现 13、15 和 16 三种基数，木本种则为 15 和 16，但以 16 为主。在至今已有记载的 20 多种中，木本种尚未有 x = 13 的报道。Mangaly (1968) 对北美的 8 个草本种(草本种主产美洲东部)作了研究，除 *S. pseudo-china* 2n=30 外，其余均为 2n=26，比较一致。而东亚的二个草本种出现多种基数，确是较特殊的。Mangaly (1968) 认为：古植物学和比较形态学证据强烈支持 *Smilax* 的起源地(包括木本种和草本种)是在东南亚和喜马拉雅山东部。并推测东亚的 *S. riparia* 可能是菝葜组 Sect. Coprosmanthus 的祖先类型，从亚洲经二条路线 (向东和向西) 迁移到北美。本文所研究的东亚草本种 *S. nipponica* 和 *S. riparia* 的核型构成以 sm 和 m 染色体为主，而 Mangaly 报道的 8 个北美草本种全为 st 染色体。按核型进化的一般规律，似乎也支持 Mangaly 的上述推测。然而对于 *Smilax* 属染色体的原始基数是多少，目前尚是个疑问。

本属染色体绝对长度平均变化范围在 1—6μm，草本种略大于木本种，2n = 26 的略大于 2n = 32 的。染色体属中小型。从已研究的 5 个种的核型构成中，可以得出 *Smilax* 属核型的基本轮廓：具 4 对 L 型染色体(包括 4x 的 *S. china* 也基本符合)，2—5 对 M 型染色体。在染色体类型上，以 sm 和 st 为主，核型大多数为 3B 型，但已出现 3C 型 (*S. nervo-marginata*)，很不对称。5 个种的对称性从高到低的排列顺序与经典分类中的现行排列是一致的，即从菝葜组到土茯苓组，从草本到木本。二个组的核型界限从目前尚难以找到，有待全面深入地研究。

多倍体现象在本属已知不多，仅在二个种内有过记载：Nakajima (1933) 报道 *S. china*: n = 30 和本文记录 2n = 96；另一个种是 *S. ovalifolia* Roxb; Goldblatt(1982) 记载 2n = 96。在草本类群中尚未有多倍体记载。*S. china* 的分布区很广，核型的多倍化现象揭示了该种可能正处于分化阶段。

关于 *Smilax* 属性染色体的研究，Lindsay (1930), Jensen(1937), Nakajima(1937) & Mangaly (1968) 等人都做过工作，一般认为最大一对为不等对，可能为性染色体，属 XY 型，但都无详细的分析数据或图象，而且都无定论。我们对 *S. nipponica* 的 ♂♀ 植株的分别研究结果(见图版 1:1—7，图1: A,C,D和表 2) 表明：♂株的第一对染色体为

明显不等对，基本可确认是性别分化的染色体基础所在，属 XY 型。但对 *S. davidiana* 的研究结果（见图版 2：4,5 和表 3）不很明显，提示我们还需做大量深入细致的工作，才可能搞清这个问题。

**Appendix** The source of the materials

(1) *Smilax nipponica* Miq., Mt. Siming, Zhejiang, on the edges of secondary forests on mountain slopes, 800m. April 21, 1988. 傅承新 88032, 88045, 88046.

(2) *S. riparia* A. DC., Mt. Tianmu, Zhejiang, in forests of mountain slopes, 600—800m. May 28, 1988. 傅承新和张原 88267。

(3) *S. sieboldii* Miq., Mt. Tianmu, Zhejiang, in bushes of mountain slopes, 1 400m. May 29, 1988. 傅承新和张原 88328。

(4) *S. china* L., Xikou Town, Zhejiang, in secondary forests of mountain slopes, 100m. April 21, 1988. 傅承新 88025; Shangyu Town, Zhejiang, in secondary forests of mountain slopes, 80m. April 22, 1987, 傅承新 871002。

(5) *S. davidiana* A. DC., Mt. Tiantai, Zhejiang, by roadsides on mountain slopes, 200m. April 19, 1988. 傅承新 88010, 88011。

(6) *S. glabra* Roxb., Mt. Yu, Zhejiang, on the edge of secondary forests on mountain slopes, 400m. Nov. 26, 1987. 傅承新 87384, 87212.

(7) *S. nervo-marginata* Hay., Mt. Yu, Zhejiang, on the edge of secondary forests on mountain slopes, 400m. Nov. 26,1987. 傅承新 87002; Nov. 20, 1988. 傅承新 88372, 88386。

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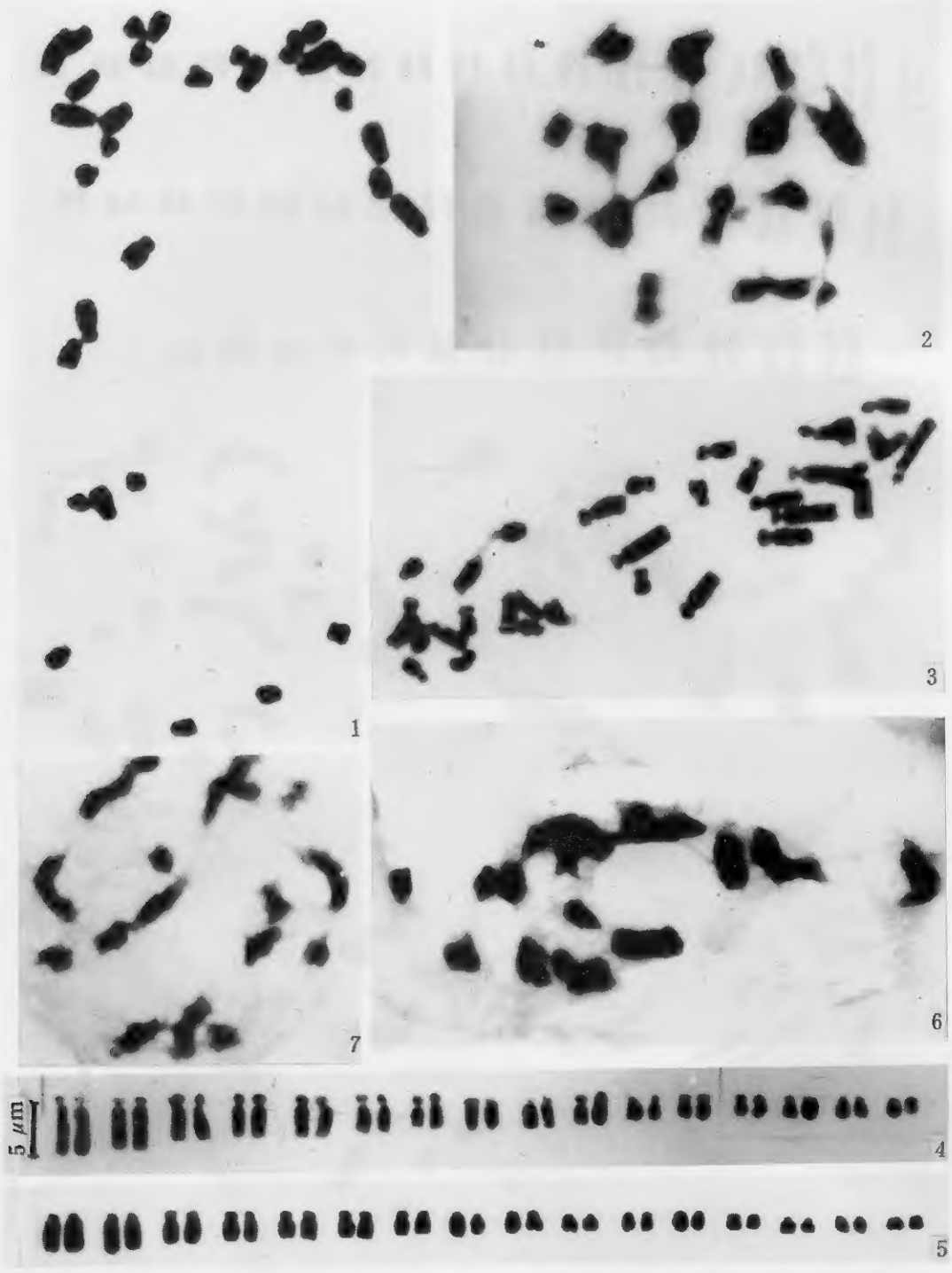
## 图版说明 Explanation of the plates

**Plate 1** *Smilax nipponica*, 3 & 7. A type, 2n = 26; 1 & 2, 5 & 6. B type, 2n = 32; 1 & 6. the karyotype of the male; 2 & 5. the karyotype of the female; 4. MI in PMCs, showing 16 bivalents. The arrows indicate the 1st pair of chromosomes, which may be sex-chromosomes. The bar = 5μm. 4(×1800); 5—7(×2000).

**Plate 2** 1—5. *S. davidiana* 2n = 32 1 & 5, the female; 3 & 4, the male; 2, MI in PMCs, showing 16 bivalents. 6. *S. sieboldii*, anaphase II in PMCs, showing 16 chromosomes. 7. *S. china*, MI in PMCs, n = 15. The bar = 5μm. 1, 3(×2000); 2, 6, 7 (×1800).

**Plate 3** 1 & 5. *S. riparia*, 2n = 30. 2 & 6. *S. glabra*, 2n = 32. 3 & 4. *S. nervo-marginata* var. *liukiuensis*, 2n = 32, the arrows indicate the 1st pair of sm chromosomes. 7. *S. china*, 2n = 96 (6x), the arrows indicate the t chromosomes. The bar = 5μm. 4—7(×2000).


see explanations at the end of text

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